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ABSTRACT

The term, "schema," used largely as a descriptive convenience rather than a theoretical guidepost in social psychology is examined through an analysis of its development, function, and structure. This paper articulates a model of schema development in adults by defining a schema as a representation of some stimulus domain and a set of rules or plans for processing incoming material and drawing inferences from that material. Data and impressions regarding the four stages of schema development are presented, paralleling the developmental stages that children go through in acquiring grammar and lexical concept. Since few studies have looked beyond a linear relationship between schema processing and expertise, the issue of multiple stages is identified as an area for future research effcts. (Author/CS)

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The Development of Schemas¹

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Schema is a term that has appeared increasingly in the social psychological literature, but its use has been largely descriptive rather than heuristic. It is as if we have some sense of when a schema is there, but not much sense of what to do with it. Serious study of the development of schemas is one promising direction for making schemas more than a descriptive convenience, because the more we know about how they develop and change the more likely it is that we can use the concept to generate predictions regarding what inferences or errors an individual will make. We define a schema as the representation of some stimulus domain and a set of rules or plans for processing incoming material and reaching further inferences (Taylor & Crocker, 1980). We will be concerned here with adult development and will be presenting some data and some impressions regarding four stages that schema development seems to go through: a rudimentary (or episodic) phase, a stereotyped phase, a relative expert phase, and an automatic phase.

The first hypothesis is that at the earliest stage of development when no true schema exists, very rudimentary knowledge functions schematically. Specifically, rudimentary knowledge may consist of a

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specific example with which an individual has either personal or vicarious experience (such as "the last time one of my plants lost its lower leaves, it had been over-watered"). Or, it may consist of one or two basic tasks (such as watering the plants).

The important point is not that schemas begin as very rudimentary and often example-based strategies-- indeed, it is hard to imagine how it could be otherwise--but that they seem to be quickly used to represent the general case and make inferences about other seemingly similar instances. People seem to be rather liberal in their use of rudimentary knowledge, like the proverbial child with a hammer who hammers everything in sight.

Our own evidence for this comes from John Winkler's thesis pilot work which concerned the development of political schemata. Winkler had subjects fill out questions on a political knowledge test and in a separate phase rate features for the extent to which they were representative of communist nations, democratic nations, developed countries, and underdeveloped countries. There was a group of subjects who could be said to have very rudimentary political knowledge indeed! They believed, among other strange impressions, that Berlin is the President of Germany; Algeria and Ensenada are countries in Central America; and South Africa, Israel, and the U.S. are all OPEC nations. While these subjects lacked knowledge about communist nations and about democratic nations in general, they reported that they used their knowledge of an example, specifically the USSR and the U.S. respectively, to make inferences. This is in contrast to the more knowledgeable subjects who reported they used their general knowledge of communist and democratic nations. Unfortunately, since we had not anticipated this kind of finding, we had no formal way of differentiating between example and schema-based impressions. However, the work by

Nelson on children and elsewhere by Joanne Martin on adults is similar to our own inferences, suggesting that people will generalize fairly widely from a single case or two cases.

Next, there is what one might call a stereotypic or novice phase. We term it "stereotypic" because the most representative attributes of the general case seem to be featured with the less central attributes acquired only later. For example, in acquiring a schema for firemen, people begin by learning that firemen fight fires, the activity in which firemen are stereotypically represented, and only later learn that fighting fires actually constitutes an extremely small portion of a firefighter's time. Thus, stereotypic attributes may be those with which an individual comes into most frequent or early contact, without their necessarily being the most important, time-consuming, or frequent in occurrence. At this stage, too, the schema seems to be rather over-zealously applied, a point I will return to shortly. Hence, our use of the term "stereotypic" for this stage characterizes both the content of the schema (in terms of a preponderance of representative or stereotypic attributes) and the process by which it is used (i.e. overgeneralization from a little information).

In a study several years ago, Judith Livingston and Shelley Taylor (note 1) investigated schemas by having firefighters answer certain questions about college students and college students answer questions about firefighters. One of the main outcomes of the study was that Livingston had firemen asking her out for weeks afterwards, but some trends also emerged. First, each group had somewhat negative stereotypes of the other. The firefighters assumed that college students drink and make trouble; the students assumed that firefighters fight fires and play poker.

These results are not in themselves interesting, but the assumptions of stereotypic structure and over-zealous application lead to a series of hypotheses regarding what kinds of inferential errors will be made. For example, the importance of stereotypic attributes is likely to be over-estimated; the absolute number of elements, such as tasks or activities involved in a schema should be underestimated; and the importance or amount of time devoted to less representative attributes or tasks is likely to be underestimated. Our results showed that although firefighters had reasonably good ideas of what students do (they somewhat underestimated the self-reported studying time of students and over-estimated students' self-reported goofing off time), the students had a rather poor idea of what the firefighters did. First, as we had expected, they listed fewer tasks than firefighters actually perform, and second, those tasks were fairly stereotypic. In order of frequency, the students assumed that firefighters fight fires, answer false alarms, get trapped cats out of trees, and either play cards or sleep the rest of the time. In fact, according to the firefighters, about 1-2 hours of their shift is spent working on equipment, 1 hour is spent writing up reports, 2 hours are spent on education either in class or reading about new firefighting techniques, about an hour is spent on drill, and most of the rest is spent on answering false alarms, checking out alarm systems and hydrants, and inspecting buildings. One firefighter added: "sometimes we fight fires." According to our firefighter respondents, no time is spent playing cards or sleeping, unless one is on night shift. In answer to a cover question, "What one thing would you like the public to know about firefighting?" several respondents answered: "That we are not lazy or stupid and do not sit around playing cards all day!"

The next set of predictions concerns inferential errors. If an individual with a stereotypic schema is asked to predict what is likely to go wrong with some enactment of the schema, that person is likely to assume that errors occur around the central attributes or tasks. We asked our student and firefighter subjects, "if something goes wrong at a fire, what is it likely to be?" Students said, "the building collapses," "someone is trapped inside" or "no water supply." The firefighters' response was "no water supply due to a burst hose or frozen hydrant," "blocked streets due to traffic or snow pileup," and "going to the wrong address." Ceiling collapses or building explosions were less commonly cited, and someone trapped inside was never mentioned by a firefighter. Our take on these differences is that, as predicted, the students are assuming errors are made around the central task (i.e. fighting the fire), whereas the firefighters are reporting errors of coordination or organization, which we suspect may be more generally true when a schema involves a lot of different elements.

The next set of studies further fleshes out this stereotypic phase by comparing novices' perceptions with those of relative experts. In this third stage of relative expertise, the schema user seems to become more attentive to inconsistencies between data and the schema, and restricts schema use somewhat more than in the stereotype or novice phase. A set of studies on political schemas speaks well to these points. In a series of four studies, Fiske, Kinder and Larter (note 2) gave subjects ambiguous descriptions of unfamiliar countries (e.g. Mauritius) to which they attached labels such as communist or democratic. Subjects were then asked to make inferences about these countries. Results indicated that "political novices (those in the stereotype phase)...recalled schema-

consistent information..., organized memory in schema-consistent clusters..., made schema-consistent inferences..., and had schema-guided affective responses..." In contrast, the (more) politically experienced focused on the complexities and ambiguities of the data; (these relative) experts recalled, clustered, predicted, and reported feeling on the basis of salient schema-based inconsistencies in the data."

Winkler (1980) also examined political schemas and reached strikingly similar conclusions. He had college students subjects complete a political knowledge task and divided his subjects into experts and novices. Subjects were then presented with the names of nations, such as Italy and Yugoslavia, and were asked to judge the extent to which a mixed set of democratic, communist, developed, and underdeveloped features were characteristic of these nations. Each set of features were then analyzed as a function of the stimulus nations' "real" categories.

He found that experts were somewhat better at identifying the congruent features of a stimulus than novices, i.e., developed features for developed nations, communist features for communist nations, and so on. Experts were also more sensitive to incongruent details; they rated democratic features as less characteristic of communist nations than did novices, for example. At the same time, expert subjects dimensions seem to be more highly correlated. Consequently, for example, experts' ratings on development features were more influenced by the stimulus nation's political category than were novices' ratings.

Winkler (1980) drew two conclusions about how novices and experts schemas differ: First, novices are attentive to what is characteristic of a schema, while experts are also attentive to what a schema is not. Within one dimension of a schema, experts articulate more between representative and nonrepresentative aspects of a stimulus. However,

experts' dimensions are more highly correlated; whereas novices seem to use one dimension at a time experts seem to employ several dimensions simultaneously.

Moving away from representation differences to processing differences, it may also be that at this relative expert stage, individuals actually prefer inconsistent or ambiguous schema-relevant material. That is, one can argue that in the stereotypic phase one is simply trying to get the schema down, and so prefers similar or redundant material. At the relative expert stage, however, the same old thing does not provide any new information, and more ambiguous or inconsistent information may actually be preferred, because it enables an individual to learn.

Why would we expect to find a conservative shift with expertise? The cautious approach of the relative expert may well serve to pull in the schema's boundaries, refine it, and qualify it. This honing process can remove many of the remaining errors in the schema making it possible for the schema to become a habit. The honing process may consist of building in examples of false positives and false negatives with rules for detection. A linguistic representation might be, if a plant's leaves begin to drop off it may be over-watering, unless it has been very hot, in which case the plant could be scorched, or unless it has been in its pot a long time in which case it could need a new pot, or unless there is some sign of a pest such as webs fuzz nibbled leaves, or scale. Or, it may simply be getting ready for winter.

Before moving to the next stage, I want to point out some parallels in other fields. After working out this model, I became acquainted with some of the literature on developmental psycholinguistics and learned that these three hypothesized stages are mirrored in the work on how children develop a sense of grammar (Brown, 1973) and in research on

children's development of lexical concepts. These fields also document the over-generalization of relative novices and the conservative shift that comes with greater expertise. Somewhat close to home, Abelson's theory of script development also contains three stages (episodic, categorical, and hypothetical) that are very similar to these.

In the fourth stage, if this stage is reached at all, the schema seems to become automatic, "mindless," even inaccessible. For very basic concepts, this process is likely to occur relatively quickly. One can identify something as red, or round, or even friendly without any awareness of the features or process used to reach that judgment. However, only some complex tasks will become automatic for most people. Many of those that do seem to have a substantial motoric component (skiing, tennis, and driving come to mind) or a very clear-cut formula. For other schemas, only some components are likely to be automatic. Hence, this last hypothesized stage is assumed not to be reached by most people for most things.

Though we have little research in social psychology on when and how complex knowledge structures become habitual, the assumption and demonstration that they do has extensive documentation (see, for example, reviews by Langer, 1978 and Nisbett & Wilson, 1977). Some accounts of learning complex skills suggest a similar progression. For example, a little book, Ways of the Hand by David Sudnow (1978) describes learning how to play jazz piano. As Sudnow describes it, at first, the hand self-consciously practices and imitates various chords and note sequences on the piano. Then it integrates series of chords with sequences of notes and plays pieces in a fairly straight forward or stereotypic manner. Then the two hands learn to coordinate with each other.

Then suddenly, jazz improvisation comes out of the hands, including chord sequences, syncopation, and melodies never before played. At this point, according to the Sudnow, the hands are just "doing it" with no conscious direction from the head.

I am, for reasons I have not yet successfully identified, frequently the recipient of self-improvement books from my friends and in my obliging readings of them have noticed a consistency. It is that these expert authors are always quite clear on describing individual task components but then when they get to the business of describing the full task whether sailing (Creagh-Osborne, 1972), squash (Khan, 1967), tennis (Gallwey, 19) or jazz piano (Sudnow, 1978), they fall back on such reassuring statements as, "it will all fall into place," or "it will simply happen" or "you will do it automatically." Typically, this does not happen for me, and so I have been motivated to understand of what the automatic stage consists.

First, in terms of representation, one can argue that, at least for large portions of a schema, many of the internal linkages become so strong, that these portions become "unitized" (see Hayes-Roth, 1977) and operate as chunks. In terms of processing, the sub-elements of these chunks would not enter awareness. Hence, in the automatic stage, coordination occurs automatically. Since the chief characteristic of this stage may be the concatenation of a number of skills, given capacity limits on short-term memory, this may explain its "mindless" quality.

What distinguishes the relative expert from the automatic stage? One possibility is that, although in both one is attentive to errors or inconsistencies, the mindless stage necessitates bringing the schema into consciousness to identify the inconsistencies and set the schema back in motion, whereas in the relative expert stage, inconsistencies may be identified and remedied more quickly.

Summary

To summarize, we have some preliminary evidence for a rough theory of schema development that mirrors schema development in other areas.

Early on, the schema appears to be virtually synonymous with a single example. Later, it assumes a stereotypic shape of the most representative or commonly presented elements. Novices using stereotypic schemas over-use them being aware primarily of consistencies between an instance and a schema. Schema-based recall, inferences, and predictions are made readily, leading to a high rate of Type I errors.

However, further expertise seems to bring caution, perhaps occasioned by over-zealous application of the schema in the stereotypic phase. At this point, the information processor is more attentive to ambiguities and complexities in instances, and may be more likely to make Type II errors than Type I errors. One could say the schema-holder is oriented toward what a schema is not and holds qualified knowledge. Very possibly, this orientation sets the stage for the development of new, related, but different schemas. Finally, at high levels of expertise, an automatic or mindless application of schemas may occur. At this stage, the schema is a habit, an artistic potential, or possibly even a neurosis, depending upon its impact on others. It becomes different to either verbalize or observe.

Research Problems

In trying to draw inferences from research on schema development, several problems emerge. First, few studies have looked beyond a linear relationship between schema processing and expertise, and so addressing the issue of multiple stages is problematic. Future researchers interested in schema development should look at several points along the experiential

continuum, and not merely dichotomize their subjects into experts and novices or treat development as linear, but look for discontinuities among stages.

A second problem stems from the cross-sectional approach that previous research has taken and asks: Of what does schema knowledgeability consist? Each of us who has attempted to compare novices and experts has labeled our variable differently. Relative sophistication, experience, knowledge, and involvement are four that come to mind. Knowledgeability, experience, familiarity, and involvement all increase with increased contact with instances of a schema, and, though they are highly intercorrelated, they can lead to different processing outcomes. Two possible solutions to this problem come to mind. One is to collect multiple measures on subjects (familiarity, involvement, experience, knowledge) in an effort to pinpoint precisely what any processing change is due to. The other is to not worry about what the "experience" variable is, but to eliminate the confounds present in cross-sectional designs by looking at the development of schemas longitudinally. Though one is unquestionably creating a lot of changes simultaneously, at least the same group of subjects is followed, and one can generally point to the cause of those changes.

Unhappily, this seemingly beneficent resolution is complicated by a third problem, namely how one does a good longitudinal study. If one studies the development of a schema naturally by observing it in the field, one may have to hang around a long time to see any changes. To use the fireman schema as an example, how many months or years of observation of a child would it take to watch the schema for a fireman develop, and even then would it actually move beyond the novice phase? If, as is more likely, one decides to speed up the developmental process by presenting instances of the schema to the learner in a controlled

setting, by what guidelines does one choose the instances? A child's personal encounter with a fireman on a school field trip will yield different knowledge than will the child's reading of a book, The Little Red Fire Engine, which will in turn yield different knowledge than that acquired by watching a neighbor's house burn down. One could argue that mode of experience is a random factor, but I think that is unlikely to be true. Rather, contact with certain types of experience may occur more frequently in the early stages of schema development than in the latter and vice versa. For example, the type of knowledge that prompts a new schema in the first place may be more dramatic than that which merely enriches an already-existing one.

As I mentioned earlier,

novices in the stereotypic phase may prefer consistent information, whereas relative experts may prefer more ambiguous information. People may have particular modes through which they prefer to learn or enrich their experience. Or, having acquired one type of experience, they may selectively choose another. Hence, the learning process is likely to be both active and interactive. Because there seems to be no clear methodological solution to the problems raised, it may be that only the checks raised by a multi-method approach will be sufficient.

The results presented here also raise some very intriguing questions about the development and use of knowledge. Why, for example, are schema users so extravagant in the novice phase, but cautious in the expert phase? What prompts over-generalization of limited knowledge? What, exactly, prompts the conservative shift? Second, are there multiple forms of schema initiation? For example, if there is no single dominant example around which to structure a new schema, will one use the nearest best schema to interpret new information? Finally, what schemas will go automatic?

To conclude, interest in the concept of schema has been great, but the term has been used largely as a descriptive convenience rather than a theoretical guidepost. One potentially promising direction for understanding the structure and functions of schemas and in pointing the way toward a schema theory is through an understanding of how schemas develop. We have tried to articulate a modest first step in that direction.

Table 1. The Development of Schemas

<u>Schematic Stage</u>	<u>Knowledge Representation</u>	<u>Characteristic Application</u>	<u>Strategy and Processing Characteristics and Liabilities</u>
Rudimentary	Concrete, specific knowledge, such as a single example, or basic task.	Liberal	Type I errors of identification and use. Seeking similar examples?
Stereotypic	Abstract, representative knowledge (rules); surface-based causal model.	Liberal	Type I errors and overzealous focus on stereotypic attributes. Seeking consistent information?
Relative Expert	Abstract but qualified knowledge (e.g. exceptions to rules built in); "deeper" causal model.	Conservative	Attention to inconsistencies within schema; possible inability to shift out of schema appropriately. Seeking ambiguous marginal examples or information?
Automatic	Abstract but qualified, highly coordinated knowledge typically not brought into awareness; organized in chunks.	Automatic	Possible difficulty in identifying sources of error; possible slow response time for atypical situations.

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